WATERSHED ASSESSMENTS FOR GEORGIA COUNTIES AND MUNICIPALITIES

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Abstract. The hydro-ecological connectivity of stream networks undergoing land-use changes is motivation for combining watershed and water quality modeling with biological assessment techniques. Watershed characterization and modeling along with biological monitoring are presented as components of an approach to assess current watershed integrity and predict environmental impact based on anticipated growth. Public education and stakeholder feedback are additional elements that, along with the results from the assessment, are used in recommending management practices to address existing problem areas and/or maintaining current watershed conditions. These assessments serve to provide a database for long-term planning as well as educate the public on activities within their watershed.

INTRODUCTION

The Georgia Environmental Protection Division (GAEPD) introduced permit conditions to the National Pollutant Discharge Elimination System (NPDES) permitting process requiring comprehensive watershed assessments. The goal of the GAEPD was not only to acquire current watershed information about counties and municipalities but also to give citizens a means to protect and improve the health of their watersheds. Since comprehensive watershed assessments are now mandatory to obtain a new NPDES permit or to renew an existing permit, the demand for performing such studies has increased dramatically. Integrating biological assessment techniques with traditional water quality monitoring (chemical and physical monitoring) is a fairly new concept and presents a challenge to any group attempting to conduct watershed assessments.

An important step in developing a process for assessing watersheds is to formulate a definition that can be easily understood by stakeholders and can be expanded as the projects change. A good working definition of watershed assessment is: the use of chemical, physical, and biological indicators to determine the current health of a watershed. Also included is predictive modeling of watershed conditions and suggesting management practices that will maintain and improve the health of the watershed. This definition, along with guidelines set by the GAEPD in *Planning for Domestic Wastewater Systems, Appendix 2,* sets up the framework to accurately assess watersheds.

The objectives of a watershed assessment are to combine the results from biological assessments with findings of water quality testing to show the health of watersheds, link these findings with various computer models to predict the impact of growth on watersheds, and use modeling results to provide a reference that can be used in the development of city or county management plans.

WATERSHED ASSESSMENT APPROACH

The approach for conducting watershed assessments presents a challenge to those doing the work as the methods utilized are variable and can be easily altered as projects progress. Assessing the current conditions is the most quantifiable aspect and involves biological, physical, and chemical monitoring of key streams within a watershed's boundaries. Simulative modeling, however, is needed to illustrate impacts of future development. It involves collecting large amounts of water quality, land use, climate, and flow data and encoding the information into watershed and water quality computer models as well as interfacing with Geographic Information System (GIS) databases. Since every model is different and the availability of existing data can vary from extremely good to extremely poor, the modeling process changes with every project. Like the modeling process, the development of a plan to manage a watershed is flexible but complex.

Determining Current Watershed Health

The biological assessment procedure involves visual review of stream bank quality and local vegetation, assessment of benthic macroinvertebrate (aquatic insect) populations and measurement of fish populations. Using the physical and biological information and the Environmental Protection Agency's (EPA) Rapid Bioassessment Protocols (RBP), a quantative score is assigned to each stream site. Indicator species of benthic macroinvertebrates and fish indicate if the streams are nonimpaired, slightly impaired, moderately impaired, or severely impaired. The RBP process is very involved, and is described in more depth on the EPA's website.

Water quality sampling involves traditional methods. The samples collected are tested for standard parameters such as biochemical oxygen demand, chemical oxygen demand, fecal coliform, total suspended solids, conductivity, and dissolved oxygen. In addition to the typical parameters, streams listed on the 303(d) list of impaired waters are tested for the parameters in violation.

The integration of water quality, biological integrity, and habitat provide not only a snapshot of the condition of the streams within a watershed, but also a historical view based on fish and macroinvertebrate richness.

Determining Future Watershed Health

Modeling approaches range from very simple spreadsheet-type programs to complex computer programs and can be applied to watersheds from rural farmland to urban areas. Choosing the correct model for a watershed assessment is critical. Some models, such as Annualized Agricultural Non-Point Source Pollution Model (AnnAGNPS), were developed for agricultural areas, while others, such as Soil and Water Assessment Tool (SWAT), were developed for a mixture of agricultural areas and suburban areas, still others, such as Storm Water Management Model (SWMM), are capable of modeling urban areas. These watershed models used in conjunction with water quality models such as Enhanced Stream Water Quality Model (QUAL2E) and Water Quality Analysis Simulation Program (WASP) are used to accurately predict the impact of future development on watersheds.

Models are calibrated by comparing existing data to predicted data and manipulating the data sets until they are relatively similar. Some of the types of information needed to run the majority of the models include GIS based maps of land use, topography, and delineated watersheds, land applications of chemicals (pesticides and fertilizers), water quality data, projected areas for development, climate, and soils data. Most models require much more in-depth data which can be acquired by researching the model.

Watershed models return results based on various land use scenarios with each run of the model depicting a different land use. The model then returns pollutant loadings, flow, and other parameters for each scenario. The results from the watershed model are integrated into a water quality model. The water quality model will determine future water quality and ultimately future watershed health.

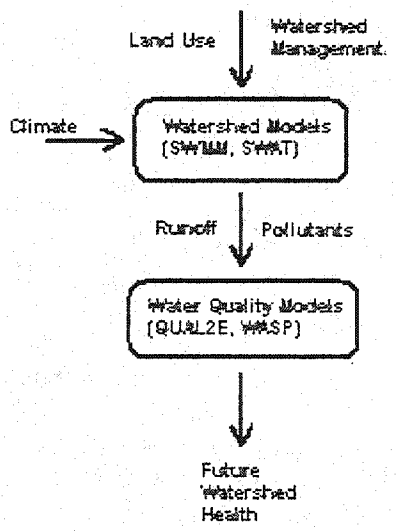

Figure 1. Modeling Process.

Watershed Management

A watershed management plan is developed based on the findings of the current watershed health study and the model predictions. The plan is the main product of a watershed assessment that will be required in the NPDES permitting process. The management plan boils down to the development of BMP's including good land use planning, adhering to the land use plan, enforcing State and Federal laws, protecting stream buffers, minimizing runoff volume and peak flows and stream bank restoration. Most importantly, a management plan is a means to encourage citizens to actively participate in maintaining watershed health. The plan outlines steps that should be taken to maintain and improve a watershed and gives citizens and administrators goals and tasks, as well as information on how to reach and meet them.

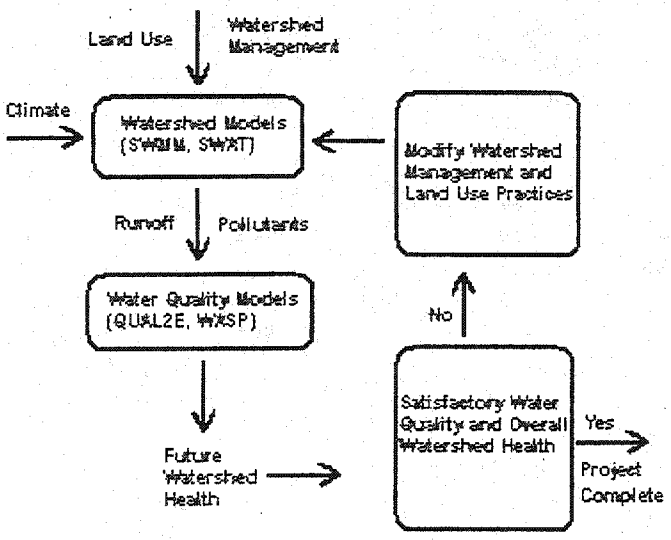

Figure 2. Models in Management.

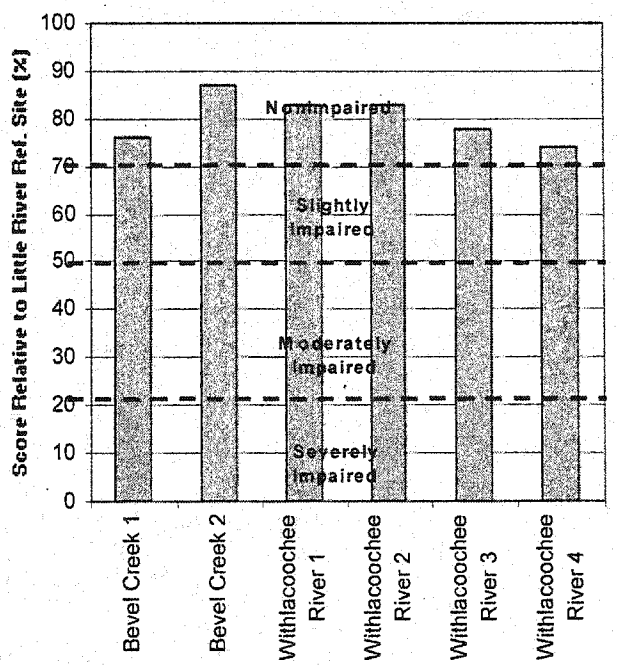

Figure 3. Total RBP Score.

RESULTS: A CASE STUDY

The Watershed Assessment Team is conducting several watershed assessments around the State of Georgia. These projects include, Millen, Valdosta, Thomasville, Fort Valley, and Lowndes County. The following results are from Lowndes County, but are representative of results from any of the watershed assessments currently in progress.

Seven field sites in Lowndes County, Georgia were selected for monitoring with one serving as the reference site. These sites were chosen based on their location relative to significant stream junctions or to NPDES permitted discharges. The Total Rapid Bioassessment Protocol Score for all of the sites is given in Figures 3. This total score is a combination of habitat, benthic macroinvertebrate population, and fish population scores. Standard water quality tests were also conducted on all of the sites, but were too numerous to include in these results. The water quality and biological assessment results indicated that, compared with the reference site, watershed health is very good.

The data from the biological assessments and water quality testing, along with some historical water quality data, were used to calibrate the SWAT model for the Lowndes County Project. Model results will be used in implementing the county's management plan regarding future development.

DISCUSSION

At the conclusion of a watershed assessment, a community will have access to extensive water quality, biological, land use, and weather data sets. Complementing this data, the cities and counties will have a working watershed/water quality model that will aid in the management of growth based on predictive modeling. Communities will be encouraged to adopt a long-term water quality and biological monitoring program to insure that their watershed management program is adequately protecting streams. This program, along with continuing involvement of the Watershed Assessment team will give communities a head start on future watershed assessments.

RECOMMENDATIONS

Collecting physical, biological and chemical data is not necessarily a novel concept. Linking these indicators together to assess watershed integrity, predict future impacts, and develop BMP's is, however, a difficult prospect. Currently hydrologic models are interfaced with GIS databases and intimately linked with water quality parameters. These indicators provide more of a snapshot view of transient water column integrity rather than a historical research perspective provided by linking them with ecological

indicators. Much research is needed to develop novel modeling approaches that will link quantifiable ecological data with GIS based hydrologic models. Including ecological impact in the simulation of land use changes will prove invaluable to long term watershed assessment.

One point of concern for the watershed assessments is that of boundary delineation. Watersheds do not naturally fall along county or municipal boundaries. It is not only difficult, but scientifically lacking to assess only along such boundaries. Efforts must be made in the future to incorporate geographically natural boundary conditions rather than governmental.

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